

Coal Seam Gas Mining: An Assault on Farming Land, Water Resources and Property Rights

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Abstract

Coal seam gas mining in the Surat and Bowen Basins in Queensland, Australia, has developed rapidly over the past decade. Many landholders are concerned about the effects of the industry on groundwater and agricultural resources and the weakness of official oversight, recently criticised by the Queensland Audit Office. Gas and water extraction is now extending under some of the most productive agricultural lands in Australia, the Darling Downs. Uncertainties remain as to the impacts of gas activities on aquifers. The water extracted along with the gas is often salty, and the method of disposing of the salts is a contentious, unresolved issue. The power imbalance between industry and landholders and weak regulation of industry hinders efforts by the industry to obtain a social licence. Governments have, to a large extent, neglected the region-wide and long-term effects of the mining. Extracting gas and water from the coal seams leaves depressurised zones, which lead to subsidence of the earth layers above the seam and leakage of aquifers into the coal seams with deleterious consequences for agricultural production. The statutory 'make good' process for compensating for loss of the aquifer water does not adequately offset the negative effects on the hydrological resources and on agricultural production. The prevailing self-regulation, lack of baseline assessment and inadequate monitoring of the mining processes are abrogations of government responsibility and the precautionary principle. As the industry is still ramping up, there is precious little time to protect agricultural land and the natural systems that underpin agriculture from potentially irrevocable damage.

Keywords: groundwater, subsidence, aquifer, salt, agriculture production, regulation

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Introduction

The current era of extraction of coal seam gas (CSG) began with exploration wells in mid-western Queensland, Australia, in the late 1970s (Miyazaki, 2005). Since then, a wide range of both demonstrable and potential adverse consequences have been brought to scholarly and public attention. Prominent

among these has been the inability of landholders to prevent incursions upon their properties by drilling rigs and extraction infrastructure, an impotence long embedded in the statutes that govern the industry. Other biophysical and socio-economic issues such as inadequate environmental assessment and baseline monitoring, depletion and contamination of

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groundwater resources, land surface subsidence, deposition of tonnages of saline wastewater, fugitive emissions of methane, boom-bust effects on employment and rents in the service towns and health effects (Haswell & Bethmont, 2016) have featured in public commentary and submissions to official inquiries.

The industry has not yet been able to negotiate an inclusive social licence to operate among the farming community, although sentiment has moved marginally towards acceptance among the townspeople (e.g. Walton & McRea, 2018; Luke & Emmanouil, 2019). This has come about particularly due to major disquiet about procedural justice, the imbalance of power between the communities affected and the industry, inequitable distribution of risks, limited assessment and oversight of the industry's activities by governments, the short-term nature of the mining set against the long-term disruption to communities and farming, and neglect of regional implications and intergenerational equity. A major community concern is the disparity in water extraction rights between the landholders who are constrained by statute and the CSG companies who enjoy practically unlimited rights to extract.

There are many accounts of the history of this industry and its current status (e.g. Towler et al., 2016; OGIA, 2019b). Concerns about demonstrable and potential effects have prompted a range of responses. For example, landholders and environmentalists collaborated to establish the Lock the Gate Alliance, a protest group of civil society raising concerns around the expansion of CSG and coal mining. The Australian Senate established a committee of inquiry into the management of the Murray Darling Basin (Parliament of Australia, 2013) with 381 submissions, which noted the broadly based opposition to the industry and recommended that landholders should be given more rights to reject company proposals. A further Select Committee on Unconventional Gas Mining established in November 2015 received 318 submissions and produced an Interim Report (Parliament of Australia, 2016) highlighting concerns about the health, social, business, agricultural and environmental impacts of the industry prior to the Committee's dissolution due to the election in July 2016. Four gas companies joined the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to establish the Gas Industry Social and Environmental Research

Alliance (GISERA; also see Glossary in online Supplementary Material), with majority funding from governments.

Federally, a 'water trigger' was established in the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) in 2013 which made water resources in relation to CSG and large coal mines a matter of national environmental significance, requiring assessment. The Queensland Government's oversight has been analysed by the recent Queensland Audit Office (2020) Report #12, *Managing Coal Seam Gas Activities*. This report specifically critiqued the assessment process under the *Regional Planning Interests Act 2014* (Qld) (RPI Act) and the need to better ensure that stakeholders' concerns are adequately taken into account, especially in regard to risk-based planning, compliance management and database management, and information sharing across agencies.

These measures, which aim to understand more about the effects of CSG extraction and/or to ameliorate any adverse effects, operate however in the shadow of unambiguously extensive pressure by fossil fuel industries and governments to unlock ever greater quantities of this underground natural resource. An example was the public call in 2021 by the head of the Australian Competition and Consumer Commission (ACCC, 2021) for changes in the way the industry operates to meet the potential crisis in gas supply to the eastern seaboard. Gas markets were not working to keep prices low, as imperatives for the gas companies were to fill contracts written in more optimistic days to export gas from Gladstone. This prompted the Australian Government to institute the Australian Domestic Gas Security Mechanism, which aims to maintain domestic natural gas supply (see Note 1 in Supplementary Material). The saga hints at pressure on the companies to produce more gas from their fields.

This paper has been prompted by anecdotal reports from the Darling Downs (see Note 2 in Supplementary Material), a geographical area of fertile, arable soils west of the regional city of Toowoomba, that CSG regulation and policy are not preventing serious and possibly irreversible damage to the productive potential of the district's natural agricultural resources. Lacking access to proprietary information held by the gas companies and the financial and technical resources to conduct independent

investigations, the authors are basing the paper on first principles of gas drilling, well construction, hydraulic fracturing and statutory accountability, supplemented by anecdotal reports of damage.

At the heart of this paper is a twin concern: first, that there is a glaring disconnect between what is happening on the ground and the aspirations of a statutory framework that assumes any adverse effects are being satisfactorily managed by conditions; and second, that there is no adequately funded body sufficiently empowered and independent of commercial or political influence to confirm the validity of the opposition to this industry expressed by numerous landholders, First Nations, scientists and environmentalists.

The paper first examines the operational issues – disruption to farming, management of produced water, effects of depressurising coal seams on other aquifers, and potential for connectivity and subsidence. It then outlines issues around the disquiet in the community about the regulatory regimes under which CSG mining is allowed to operate, demonstrated through landholder responses, a Queensland Audit Office review, regulation philosophy and industry impacts on property. The Conclusion summarises these findings and the portents for future coexistence of agriculture and CSG mining. The historical background to the current CSG industry operation in the Surat and Bowen Basins, parts of the Great Artesian Basin and major agricultural production areas in Queensland is given in the Supplementary Material (Section 3).

Aboriginal People and Groundwater

First Nations' interests in the health of their Country, which has in many parts been widely affected by gas activities, are less recognised and protected in law than even agricultural practices. Moggridge (2021, p. 15) documents “many stories that indicate the linkages between surface water, groundwater, lakes and rivers, cave systems, natural springs, thermal springs, rain events recharging the aquifers”. These stories record a precise classification system for sites within First Nations' Country, upon which their survival depends. While an adequate treatment of First Nations' interest in gas extraction and disruption of the land profile is beyond the scope of this paper, all stakeholders are urged to access First Nations'

insights into the interconnectedness of resources that contemporary science treats separately, in order to enrich public debate and official policy about the industry. The law requires this: section 28(2) of the *Human Rights Act 2019* (Qld) specially protects the rights of Aboriginal and Torres Strait Islanders, which must be upheld in all government decisions. An investigation of the adequacy of regulations to respect First Nations' interests in protecting their Country is overdue for further research, as recommended by Trigger et al. (2014).

The Issues

Landholder Rights

Unlike the major portion of Queensland's inland pastoral country (which is predominantly leasehold; see Note 3 in Supplementary Material), most of the Darling Downs arable lands are freehold. Owners of freehold land enjoy broad powers to choose whether to develop their land and are entitled to peaceable possession and to eject trespassers. These rights are grounded in common law, which evolved to protect landholders from unjust intervention by mediæval governments (Edwards, 2006a; Vanderduys & Edwards, 2004).

However, ownership of ‘minerals’ and ‘coal and gas’ is normally not included in freehold and leasehold titles in Australia, and in Queensland these resources are allocated by two separate regimes of tenure administration. The separation of resource tenure from land tenure is partly a consequence of the opportunistic nature of discovery of deposits of resources, but at its core is a tool for securing the public interest, to allow the state to capture royalties and to manage the potentially deleterious side effects at a scale that would defeat individual landholders. However, these beneficial outcomes require the state to avoid regulatory capture by the companies and also to defend the property rights of landholders, which itself is a matter of public interest.

From the separation of Queensland as a colony (1859) (and even before then – see Christensen et al., 2008), the legal doctrine of Crown prerogative was used to reserve minerals to the Crown out of many or most grants of land, but the practice was not universal and many early titles conveyed coal to the owner. These rights, which exempt the owner from paying royalties and so are immensely

valuable to modern coal miners, were preserved by section 21A of the *Mining on Private Land Acts, 1909 to 1965*. However, the *Mining on Private Land Act 1909* reserved “minerals” to the Crown in all subsequent land grants. The 1909 exclusion has been extended to include unconventional gas (shale or CSG) by statute (see Note 4 in Supplementary Material).

The extraction of coal seam gas is administered under the statutory regime for allocating oil and gas (*Petroleum and Gas (Production and Safety) Act 2004* (Qld)) (P&G Act). Under the Act, the state allocates rights as: first, a licence to prospect; and then, via, for example, a petroleum lease, the right to produce gas. For gas, this right comes also with a duty to manage the associated produced water as a regulated waste under the *Water Act 2000* (Qld). This enables the applicant company to enter into an agreement with the landholder to gain access to the underground resource and to the land to establish access roads, a pad to drill the gas wells, and the gathering lines to take the gas and water away to treatment plants. The landholder’s right to exclusive possession of the land is compromised (Taylor & Hunter, 2019).

Typically, the CSG company is required to negotiate a Conduct and Compensation Agreement (CCA) with the landholder, to compensate for the effect of the CSG activities on farming activity. The CCA sets out the arrangements for activities to be undertaken on their land and also any agreed compensation to ‘make good’ damage likely to be caused by the CSG operations. The management of impacts is typically addressed under an adaptive management approach explained in more detail in the Precautionary Principle section of this paper.

Various gas companies are now drilling under farms from neighbouring properties, thus affecting the land used by the farmer without establishing ground structures on the under-drilled farm. There are anecdotal reports of at least 48 wells of this kind. To date, companies have not considered that drilling under land would trigger the rights of the landholder to enter a CCA or to negotiate ‘make good’ arrangements. This interpretation is subjective and arguable, given the significance of the activity and its potential consequences. The inability to enter a CCA leaves landholders with under-drilling at a distinct disadvantage, particularly as it impedes the

ability to ensure that there are baseline assessments of groundwater resources or land levels. Without baseline assessments, it is exceedingly difficult for a landholder to then demonstrate that the drilling has been the cause of any effects on their land after the fact and to obtain compensation or seek enforcement against an operator. Arrow Energy was fined in March 2022 for not even notifying landholders that the company was undertaking directional drilling under land (Queensland Government, 2022), as a result of an investigation by the government after many landholder complaints into the legality of the activity.

Companies usually require that individual CCAs with their ‘make good’ arrangements not be made public. This reflects a huge imbalance of power between the mining company and the affected landholder, who has no simple options for redress and is denied the knowledge essential for collective action with neighbours. The negotiation process can be contentious, expedient and inequitable (see also Taylor & Hunter, 2019).

Alarming, more than 233 historic landholders’ water bores have already been depressurised to less than the trigger level where ‘make good’ compensation is required under the *Water Act 2000*, as outlined by the GasFields Commission (GFCQ, 2022a) and as described on the Business Queensland website (Business Queensland, 2020, 2022). More than 700 more bores are predicted to be affected to a level requiring ‘make good’ (OGIA, 2022). Further, while there are ‘make good’ arrangements for loss of groundwater in bores under the *Water Act 2000*, there is currently no ‘make good’ framework for subsidence.

In summary, the Queensland Government has allowed directional drilling under land for which there is typically no agreement with the landholder about access or compensation for damage, nor sufficient baseline assessment to properly remedy any effects. The GFCQ has negotiated a Landholder Indemnity Clause for use in new CCAs which they believe obviates the issue, but its validity has not yet been tested (GFCQ, 2022a,b). At issue, however, is the lost value of the natural capital when land subsidence is caused over a large scale and aquifers are drained, not to mention loss of annual productivity and destruction of First Nations’ interests. In addition, an unfair onus is on the landholder to

prove that any impacts, including subsidence, are the result of the gas activities, which is impossible if no baseline assessments were undertaken.

Legislation sets the stage for conflict between incoming holders of gas tenure and the holders of tenure over the land surface. Legislation is not preventing damage to the land surface or landowners' assets and does not give landholders the right to refuse access.

An informal insight into the Queensland Government's dismissive approach to landholders' concerns was given by Acting Director-General, Department of Resources, Mike Kaiser, during a panel discussion of the Community Leaders' Council on 10 June 2021 (GFCQ, 2021a): "... these are deeply emotive issues" that will not be resolved solely by science and evidence, which is not wrong, but misleading, because emotive responses are generated on account of real-life transgressions. Kaiser continued (GFCQ, 2021a): "Regulation can tell a company what it can do and can't do, but it can't tell a company what it *should* do ... considering 'should do', you start getting into ethics and moral considerations, and trust ...". Yes, the companies *should* work harder to earn the community's trust, but the statement seems to absolve the Department as simply 'regulator' (a minimalist description of its role) from responsibility for protecting the public interest and for creating a trustworthy regime for the industry, using a range of tools including tenure allocation, regulation *sensu stricto*, policy, public administration, taxation and suasion ('jawboning'). The Council's theme of "Cultivating Coexistence – learning from experiences, facing challenges and harnessing future opportunities" (GFCQ, 2021a) is also telling, as it seems implicitly not to envisage the prospect of refusal of applications for CSG development.

CSG Drilling and Disruption of Farming Activities

Directional or deviated well drilling along a coal seam is an advancement in the drilling process in the Surat Basin recently introduced from the USA, where about 17% of oil and gas wells are now 'horizontal' (EIA, 2022). For the Surat Basin Cumulative Management Area, Arrow/Shell outlines how this would minimise the surface area required for up to eight gas extraction bores and associated handling

systems which are co-located on the same drilling pad. The deviated wells run in different directions from the well pad to tap gas in the narrow, multiple coal seams lying above each other, each bore running up to 800 metres along the coal seam. This reduces the above-ground imprint of roads and water and gas-gathering pipelines, as well as water separation and pumping station facilities. This enables gas extraction from a very large area – about 2000 ha for each planned well pad.

The proposed expansion by Origin, by drilling 7700 wells and installing 6800 km of gas and water pipelines, will have a large "development footprint" which is "likely to alter local patterns of alluvial recharge, ... [and] disrupt riparian corridors" (IESC, 2022a, p. 7). The disruption of surface water flows is likely to have a drastic effect on the vulnerability of the land to erosion during extreme weather events, which is almost certain to increase with climate change. Similarly, for Santos (IESC, 2022b) with its proposed 116 wells, dam(s) storing produced water are susceptible to overtopping in extreme weather with likely highly deleterious consequences downstream.

Gas operators have started deviated drilling on the Darling Downs Condamine River flood plain, sometimes where the landholders do not want any part of this. The concerns of landholders are several, but primarily that it will result in loss of water from the aquifers which historically have supplied irrigation water – 130 GL in 2020–2021 – to the farmers in the Condamine Balonne area (DNRM, 2012; DNRME, 2018; DRDMW, 2021), an area about 1.37M ha and 7.9% of Queensland (DES, 2018, 2022a). The Surat Gas Project in this area covers ca. 250,000 ha, a major part of it in the Central Condamine Alluvium which comprises more than 445,300 ha (DES, 2018).

Other concerns include that CSG extraction is causing subsidence (see Subsidence section of this paper; Australian Government, 2014b; OGIA, 2022; GFCQ, 2022d) which severely constrains the productivity of cropping land and ease of conducting farm operations. There is concern that tractors will bog in subsided areas as water will pond there; that soil compaction is potentially greatly increased (Al-Ahatib Mohammed et al., 2021); and that channels created by the compaction will disturb flood erosion control (Queensland Government, 2015).

For farmers, both directional and vertical wells are an inconvenience as they have to manage farm operations around CSG-related traffic to wells on or adjacent to their farm. For example, gas-related activity can constrain crop-spraying times, introduce weeds on company vehicles and trigger erosion during rainfall events around roads and gathering pipes (Dart, 2020).

Destination and Quality of Extracted Water

The water in parts of the Walloon coal measures is less salty than the main body of CSG-produced water and has long been used for agriculture. In the Surat Basin Cumulative Management Area, more than 340 of these bores into the Walloons and other aquifers are classified as Immediately Affected Area (IAA bores), having lost so much water pressure to the CSG extraction process that they are no longer reliable for use by landholders (OGIA, 2022). The CSG companies are required to ‘make good’ lost water (DES, 2021a), but this has often been a most unsatisfactory outcome for the landholder (e.g. AgForce, 2021). Under ‘make good’ arrangements, if the CSG extraction impairs the capacity of a water bore, the resource holder must make good the impairment in the way outlined in an agreement between the company and landholder or water user. This often involves drilling the bore deeper or drilling another into a deeper aquifer. This raises issues about the comparability of the water quality and the cost of pumping it. If this option is not available or is unacceptable, a monetary recompense may be offered, or water can be trucked to the site. Calculating the value of a resource not available into the ‘forever’ future is, however, problematic.

Associated wastewater on the other hand is often very salty and unusable until re-processed, such as by reverse osmosis (RO) plants. Reverse osmosis removes most of the salts, leaving other salts (mainly sodium chloride and bicarbonate) to somehow be disposed of safely. The DES has established a stakeholder working group of about 42 persons to examine this issue. But after three meetings there has been no decision as to how to allow the CSG companies to do this, *some 25 years after the Queensland Government encouraged the development of CSG mining* (DES, 2021b) and at least 15 years after the Department deemed

evaporation ponds to be an unsatisfactory solution (Edwards, 2006b). Regardless of whether the produced water is deemed to be waste or a valuable agricultural asset, as next analysed, the current regime is unsatisfactory.

Regarding the Produced Water as Waste

Much of the CSG-produced water is currently stored in large, surface-dam constructions by the CSG companies, supposedly briefly, until treated to remove the salts by RO and afterwards in other dams prior to distribution for use (Morris, 2022). Because the RO water is pure, it can be shandied with saline water to bring it to a salinity level that is deemed not to be damaging to crop growth and soil processes. A contingency discharge to a watercourse is allowed only when beneficial use is not available for the quantity in surplus and should be allowed only under the Coal Seam Gas Water Management Policy 2012 (DEHP, 2012) on special exemption in the case of heavy rainfall events causing flooding and potential overtopping of the holding dams (Australian Government, 2022), but this is likely to change surface water quality, a key impact identified by the IESC (2022a).

While the resulting shandy may be tolerable for cattle to drink or crop plants to grow, at its heart it is not an adequate or environmentally sustainable remedy. Salts that had been immobile are being brought to the surface and mobilised into the upper catchment of the Murray-Darling system, which downstream is already carrying a burden of sodium salts far greater than desirable.

The most recent public Queensland Government Coal Seam Gas (CSG) Brine Management Action Plan draft report (DES, 2022b), in 2020 to the Murray-Darling Basin Authority for their audit of the salt loading from Queensland, recorded 26 brine ponds with a combined total of 18 GL and having an electrical conductivity (EC) ca. 40,000 $\mu\text{S}/\text{cm}$ (see Glossary in Supplementary Material for more information on salinity levels). There are now understood to be at least another nine ponds with a combined total of ca. 14 GL. The final volume of salt calculated from the proposed volume of water from more than 22,000 proposed wells would be about 5–6 million tonnes. Disposal of up to 15 million tonnes of this salt, as well as fracking waste products (see Note 5 in Supplementary Material), was approved on

13 November 2013 by Maranoa Regional Council, for a site near Stockyard Creek at Baking Board Hill near Chinchilla, to We Kando Pty Ltd.

The RO plants themselves require much energy to operate (see Note 6 in Supplementary Material). In addition to all the water-related difficulties of disposing of this water, there is an emissions-related challenge which will become only more difficult as national imperatives to reduce emissions intensify.

Regarding the Produced Water as an Asset

The current process for disposing of associated water has resulted in an economically inefficient and inequitable distribution of a *public asset* that is contrary to the principles outlined by the National Water Commission (2014). The opportunity to use the produced water in support of water reform in the Murray-Darling Basin has not been recognised by the Queensland Government in the regulations underpinned by the *Environmental Protection Act 1994 (Qld)* (EP Act) which designates it primarily as a waste product (DES, 2021; Monckton, 2018; Monckton et al., 2017; Business Queensland, 2022).

Currently produced water is provided to Chinchilla Weir (managed by Sunwater) and to irrigators near the major water treatment plants, such as Kenya located near Chinchilla, and a few feedlots and industrial users. Relatively few irrigators are contracted to take an agreed volume of water on a regular basis. Anecdotally, it appears that farmers are reluctant to sign up to re-use this recycled water, because they may be required to take it even when it is raining and irrigation is not needed. In particular, difficulties arise in a wet year with high-cost penalties imposed by the CSG company if the water is not used. Certainly, irrigators can benefit in that the cost of water is considerably less than the cost of other water in the market.

However, diversion of purified water into irrigation is of only temporary benefit to growers because it can continue only so long as seams within range of the local RO plant are being dewatered. This time period may not be sufficient to justify capital investment in farm irrigation plant.

Subsidence

Removal of the water and gas from the coal seams leaves an expanding zone of low pressure yielding

decreasing volumes of water and gas as more is extracted. Landholders are worried that water from the aquifers that they use will drain into the de-watered coal seams, which now have a lower pressure profile. This induces flow from the water-filled pores above into the zones of lower pressure in the coal seam pressure ‘void’. The water pressure (buoyancy) in this material above the coal seams functions to maintain the spatial relationship of the layers above the coal seams. The strata above the coal seams are now less supported, and their downward pressure (determined by gravity and weight/density and elasticity of the material) moves them into the ‘void’ below. This subsidence may or may not be transmitted all the way to the surface, depending on the thickness and hardness of the sandstone and alluvium strata which lie above the coal seams (IESC, 2014; Galloway, 2016; Marker et al., 2016; GUSGS, 2019; Pan et al., 2022).

A major concern of farmers about subsidence results from the lack of sufficiently accurate systems or requirements for measuring baselines on cropped land before drilling starts and the soil profile changes. The *Underground Water Impact Report for the Surat Basin Cumulative Management Area* (OGIA, 2022) has minimal recognition by way of definition, or of the cost penalty that subsidence imposes on farm operations. Further, the report does not concede that this subsidence will persist over time and affect the status of the land, virtually forever, or that it cannot be rectified. Subsidence makes the land prone to erosion, a major issue on the vertosols of the Darling Downs where farmers have, from the 1980s, developed better land management and cropping systems to overcome the sheet erosion that occurred during rainfall events.

The extraction of water by farmers from aquifers above the Walloon measures could also result in subsidence. However, the irrigators on the Central Condamine, such as the members of Central Downs Irrigators Ltd, have considerably cut back their use of this water for irrigation to meet the government-permitted extraction limits in their water use licences (Business Queensland, 2021). The limits are specified to balance offtake and recharge as an aid to sustainability. Again, ongoing measures of the field surface status would support this modelling of recharge rates.

Arrow Energy has directionally drilled under several farms in the Darling Downs near Chinchilla and Dalby and commenced to extract gas without informing the landholders, as mentioned above. Since this latest round of new drilling, subsidence has been reported in a cropping field, leading to ponding, waterlogging and compaction as the affected soil surface is now uneven and moister. Moist vertosols are compacted more than drier vertosols by machinery traffic (Al-Shatib et al., 2021). Such subsidence can have a major effect on productivity as the precision agriculture practised relies on adequate drainage in fields of shallow slope.

Methods to measure subsidence have limitations. Subsidence is currently assessed by CSG companies and the OGIA by the Interferometric Synthetic Aperture Radar (InSAR). Images captured by a satellite system can detect dynamic ground position changes such as deformation of the earth's surface. Radar signals from the satellite are bounced back from the ground to the satellite and captured by the sensor during different orbits (USGS, 2014, 2018). Small differences in the distance from satellite to the ground as the land surface moves up or down can be detected. However, the dynamic nature of cropping – with variable vegetation such as growing cotton or stubble left in conservation tillage systems or harvesting, or a rough ground surface after ploughing, or the swelling and shrinkage of heavy clay vertosols with rain or irrigation – limits the usefulness of InSAR measures of subsidence in cropping land, particularly where there may be several crops a year. The method is acknowledged to have limitations in assessing the small, early levels of subsidence which increase over the years as the earth layers compress with the reduction in pore pressure as gas and water are mined (Pan et al., 2022).

The lack of appropriately detailed baseline measurement before CSG mining starts has been pointed out forcefully by recent reports to the Australian Government from the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development. Baseline measurement is required for the proposed large expansion of gas wells in the Surat Management Area by Origin (IESC, 2022a) and Santos (IESC, 2022b). The regional effect of such development is critical to assess. Further, these reports note

the high risk that cumulative impacts will exceed threshold ecohydrological requirements, particularly where groundwater drawdown is predicted over several hundred years.

Subsidence following extraction of groundwater has been observed in coastal cities and agricultural regions worldwide, examples being Jakarta and Lagos (Galloway & Burbey, 2011; Gambolati & Teatini, 2015). In the San Joaquin valley in California, the land subsided (compacted) by about 9 metres between 1925 and 1977, a process attributed to withdrawal of groundwater. As noted by Parker et al. (2021, p. 1): “Long-term, irrecoverable subsidence is associated with inelastic compaction of aquifers.”

It is entirely plausible that mining for CSG is similarly creating large ‘voids’ with similar geophysical effects. Further, recent modelling of subsidence in China and the US indicates that the earth fissures that can also develop with water extraction from pumping are likely to be caused by an aseismic event related to a ridge in the base of the pumped aquifer (e.g. Li, 2021; Nardean et al., 2021). If such a fissure developed under a CSG salt-holding pond, it could have catastrophic consequences through salt release to the environment and, if on a farm, loss of potential irrigation and crop production. Another model shows how spatial variation in subsidence in alluvial basins can be related to the aquifer drawdown levels (Chu et al., 2021).

Legacy Coal Exploration Wells

Also contributing to the leakage of water are the exploration bores for coal mining. These bores are not often on the OGIA register and are commonly not monitored and not properly capped. Appropriate ‘Construct and Abandon’ practices have often not been followed, leaving the unlined bore as a channel for water to flow into or from the aquifers they pass through, facilitating drainage into depths below the aquitard above the coal seam and into the coal seam itself (Mallants et al., 2018). The CSG and water extraction can occur quite close to these abandoned coal bores. The coal cleat space from which the gas is withdrawn may continue up to the abandoned bore site so that aquifer leakage would be facilitated through the unplugged coal bore once the pressure in the seam is reduced by the CSG extraction. The Office of Groundwater

Impact Assessment has identified 2200 such coal exploratory well holes in the Springbok Sandstone aquifer, although there are at least 18,000 coal holes in the Surat Basin (OGIA, 2021). It is likely that many of these are not capped and plugged with cement (Mallants et al., 2018; Morris, 2020).

Some of these coal bores penetrate through to the Hutton aquifer(s) below the seam. These coal holes are also a conduit for gas and water emanating from the coal seam depressurised by CSG extraction to belch from the ground surface, where there is sufficient pressure to reach the soil surface, as has been anecdotally reported (Clarke, 2022; Smeed, 2022a).

Such a situation has recently occurred near Origin Energy CSG wells near Chinchilla on Western Downs properties. Origin voluntarily capped a few of these coal bores that were emitting fugitive methane emissions and large amounts of salty water near their CSG wells. However, it is not clear how many coal bores Origin plugged with cement (the proper method) or whether this was pressure-tested to see how effective the plugging was (Long, 2022b).

Leakage from Previously Stable Dams

Large losses of water have recently been observed from a 1200-megalitre, seven-metre deep, surface ring tank (dam), used for irrigating crops such as cotton on a property near Dalby. The losses were much more than the pan evaporation rate for the location and greater than normal seepage from previously well-sealed tanks, including one nearby of similar depth on the same property. The dam was directionally under-drilled for a production well under almost the full extent of the dam floor in 2018 by Arrow/Shell (ABC, 2021, 2022; QCL, 2021).

This loss can be attributed to a change in the hydrological profile below the dam, caused by loss of hydrological pressure and then loss in the support of the dam's clay floor seal. The base of large ring tanks across the north-west of New South Wales and southern Queensland is supported by a dome of saturated soil that is contiguous with the aquifer and is stable, as crops or trees are not extracting water from it. Leakage into and from the dome is minimal, as lateral underground flow out to less-saturated soil away from the dome is small and slow (Cottoninfo, 2018).

Walloon coal measures are as shallow as 60 metres below surface at this location, which is an area where the overlying Springbok Sandstone has been identified as immediately affected by groundwater depressurisation from CSG extraction (OGIA, 2022). Once the strata below the dam are disturbed by extraction of gas and water, they will subside and drainage from the groundwater dome can follow.

Aquifer Connectivity

Any movement of water out of the coal seam by drainage to the aquifer below would likely contain measurable quantities of a range of polluting chemicals including salt and the BTEX chemicals, even though their concentration may be below the minimum-level, permissible standards for drinking water. Benzene should be less than 1 part per billion, and other chemicals 300 to 800 ppb (DES, 2020). BTEX compounds are not permitted as chemical additives in fracking fluid in Queensland, although the long list of chemicals used does contain some unspecified compounds (Shell, 2022).

Shell/Arrow Energy has sponsored research by GISERA and The University of Queensland's Coal Seam Gas Centre (now Centre for Natural Gas) at a few wells and bores on the vertosols of the Condamine River Alluvial land, with the aim of assessing whether the overlying aquifer is connected to the coal seams by faults and fissures (Owen & Herbert, 2020). The Office of Groundwater Impact Assessment (2016) had reviewed the information on connectivity and concluded that the level of hydraulic connectivity was low.

A subsequent pilot study commissioned by Arrow, and conducted by CSIRO, attempted to use isotopic analysis of noble gases and conventional tracers to support this, but the small number of wells sampled in the study (two – and then only at three or four depths) and the differences between them indicated that each was only a snapshot in time and place and that the sampling methods for the gases need to be improved. It was acknowledged that de-pressurisation of the coal measures by CSG extraction over time could cause a change in the profiles (Suckow et al., 2021).

Research conducted by Iverach et al. (2015) at the University of New South Wales also examined gas and water movement between the Walloon

CSG and Condamine River Alluvial aquifers and measured the isotopic constitution of the bore waters and gases in several wells. The study used 16 irrigation bores near Cecil Plains, Queensland, for the data for modelling the biogeochemical processes to indicate connectivity of the methane gas in the well with the coal seam.

Genetic sequencing and isotopic analysis of bore waters in CSG development areas in the Condamine Alluvium aquifers identified methanotrophic bacteria, which in natural conditions would be expected to be out-competed by sulphate-reducing bacteria in the alluvial groundwater. Their data thus suggest that methane (as a gas or in groundwater) was being introduced into the aquifer from CSG-bearing layers through inter-aquifer leakage and/or surface leakage of CSG wastewaters (Iverach et al., 2017).

Spot Research Does Not Necessarily Scale Up

The studies described above were carried out at a very small number of locations, scattered over a vast area of agricultural lands in the Surat Cumulative Management Area, including the renowned Condamine flood plains, which are about to be mined for CSG. Some 465 out of ca. 8000 bores in the Surat Basin are on the OGIA register of bores whose water height (pressure) is being monitored, some by the gas companies. The Office of Groundwater Impact Assessment now meters water levels in 30 of these wells. It is unclear how confidently this spot research, and well data held in multiple agencies (OGIA, 2019a; OGIA, 2021), can be extrapolated and trusted to scientifically adduce (as posited by OGIA and the GasFields Commission):

- (a) that there is low permeability and little vertical connectivity of water between the aquifers now as the “intervening aquitards have not yet been subjected to significant vertical head gradients” (OGIA, 2022, p. 86) (but this does not hold if aquitards are not present or are variably impermeable or not homogeneous across their whole expanse in the Basin); and
- (b) that this will always remain so, in perpetuity, regardless of seismic events.

This contention of the OGIA that all is well is despite the large changes in the Walloon coal measures where the water level has decreased as a result

of extraction. This extraction has created zones hundreds of metres in diameter (and maybe even larger) of CSG depressurisation around the gas wellheads and altered the head pressure between the coal seam and aquifers above. This creates a gravitational force for water to flow from the upper aquifers into the huge, physically unstable, mechanically unsupported and depressurised zones in the coal measures (OGIA, 2021). The leakage into the coal seams is estimated by OGIA to be about 1300 ML per annum in the Surat Basin, but this volume is bound to increase as the number of wells in the gas production zone rises to a predicted 22,000 from the current ca. 8000 (OGIA, 2020; OGIA, 2022).

This leakage from aquifers and gas migration may occur along a range of pathways, including along existing faults. Such pathways have been meticulously and comprehensively documented by CSIRO (Wu et al., 2016). Along with well failures during operation, they will continue to occur as materials such as cement and metal casings deteriorate with age. If the well is an exploratory one and is then plugged above the coal seam, water and gas will pass if the integrity of the temporary plug gives way and if there is an annulus (space) between the casing and the rock formation.

Inadequacies of Regulatory Regimes

The CSG industry is subject to an extensive and complex network of statutory provisions, broadly clustered into gas tenure, environmental authority, EPBC Act assessment, and private contracts (see Note 12 of the Supplementary Material). A detailed explication of these provisions is beyond the scope of this article. Instead, we highlight some inherent weaknesses in the regime that collectively they create. A key weakness is the reliance on adaptive management, which is now the preferred approach of the Queensland Government towards the burgeoning CSG industry (DES, 2020b; see Note 13 of the Supplementary Material). Adaptive management, however, requires active involvement by both the company and the government for the lifetime of each installation. This is conspicuously lacking, especially once gas extraction has finished, as the company loses interest and the Departments cannot summon up the skilled staff necessary. Adaptive management is a ‘learning by doing process’, which

is in considerable tension with the precautionary principle.

Landholders' Concerns: A Recapitulation

Affected landholders, particularly in the Condamine Alluvium, have made representation to regulators and the press about the lack of progress on several issues, listed below and reported by Lock the Gate (see Note 2 in Supplementary Material; Dart (2020); Queensland Audit Office (2019); EDO (2021)):

1. Lack of subsidence monitoring or baseline assessment and apparent lack of response from agencies at either state or federal levels of government or appreciation of the urgent need for addressing subsidence issues.
2. Directional drilling of landholdings from adjacent properties without a CCA or other agreement with the landholder and often without notification nor detail of location of the well and provision of well logs on request.
3. Alienation of good-quality agricultural land, a natural resource in limited supply, against the government's previous statements that it seeks to ensure the land's protection.
4. Aquifer leakage and inadequate pre-assessment and regulation of impacts or 'make good' provisions.
5. Inadequate or non-existent capping and plugging of exploration bores for coal mining, leaking voluminous quantities of fugitive methane from the legacy bores and through waterways, and belching through ponded water in cropped fields (Smee, 2022b); and further, resulting in possible contamination by salt and BTEX-type chemicals of water used by cattle and households.
6. Potential loss of aquifer water from unlined and unplugged gas exploration wells.
7. Disposal of the millions of tonnes of brine and management of the 42+ very large dams/ponds holding brine.
8. The role of the GasFields Commission in not protecting the interests of landholders and diluting the government's accountability for regulating the gas industry; also, the Commission's Board composition, holding two ex-gas industry representatives.

On 8 February 2022, the GasFields Commission (GFCQ, 2022c) called for immediate action to resolve ongoing coexistence issues and community concerns from Arrow Energy's Surat Gas Project. The Commission, in their review of the RPI Act assessment process finalised in October 2021, found a lack of clarity and transparency around gas companies' compliance and noted that subsidence was a "significant concern" (GFCQ, 2021c, p. 1) for landholders. It called on the State Government to enter the dispute and "provide details of its expectations on compliance and how resource companies are meeting these statutory requirements" (GFCQ, 2021c, p. 1).

When Arrow reportedly under-drilled properties from a well pad on a neighbouring property without a Notice of Entry or a CCA in place, the farmers were given no advice by the Department of Resources as to their rights or information about the bore's history and location, despite repeated requests. Belatedly, the Department fined Arrow (Shell) \$1 million for not having a Notice of Entry but indicated that it was a court concern if a CCA was not in place (Long, 2022a; Queensland Government, 2022).

Queensland Audit Office's Red Flags

The Queensland Government has fragmented statutory roles around gas activities (see Note 14 of the Supplementary Material). The Queensland Audit Office (2020) report *Managing Coal Seam Gas Activities* critically reviewed the approach by the regulators in the Department of Natural Resources, Mines and Energy, the DES and the GasFields Commission in managing the increasing scale of CSG developments. It recommended that the Commission review the RPI Act assessment process to determine whether the process adequately manages coal seam gas activities in areas of regional interest, including consideration of stakeholders' concerns about exemptions and inconsistent definitions of land (Recommendation 8 and Chapter 1: Regulating the industry).

A number of specific matters requiring improvement were identified in their report, notably:

1. The need for increased clarity of regulation of gas industry activities, removing inconsistent statutes dispersed across relevant agencies,

- improving industry attention to risk-based planning and improving regulation of the impacts on priority agricultural land.
2. Dispersed and inadequate data on activities and compliance issues across agencies; and limited data sharing, hindering the collective understanding of regulatory effectiveness and industry compliance.
 3. Limited enforcement, rather a focus on education, but with too few experienced staff to do this adequately and competently.
 4. The confusion of stakeholders as to the role of the various entities involved in overseeing the gas industry, including the regulators and other Departments, the Commission, the Land Access Ombudsman and the Land Court; confusion about where to seek information or compliance action and how to deal with disputes. Four Departments are involved in the regulation of effects on agricultural land, leading to inconsistencies of land classifications and ways of dealing with land use conflicts. Key issues, such the health and safety of landholders, are falling through the procedural gaps.
 5. Where baseline data exists, it is often not shared with landholders because gas companies regard it as 'commercial in confidence', advantaging them in landholder negotiations. Landholders are restricted from sharing CCAs so that neighbours have no benchmark data from which to negotiate their own deals.
 6. Perception by key stakeholders of the lack of independence of the Commission.

Inadequacies in the Evolution of the Regulation of Agricultural Land

The regime introduced by the 1992 *State Planning Policy on Good Quality Agricultural Land 1/92* is now arguably weaker than ever. It is certainly more complicated. The original State Planning Policy 1/92 specified land classes and their potential uses. The land resource mapping underpinning the policy was deemed insufficiently detailed or prescriptive, and this led to the *Strategic Cropping Land Act 2011* (Qld) (SCL Act) which provided for designation of land into classes, a measure which weakened protection of some of the lower-quality soils. Under the

Newman Liberal National Party Government (2012–2015), after the rapid expansion of the industry without proper assessment of regional effects such as aquifer integrity, the SCL Act was repealed. Later, the *Land Access Review Implementation Report* (2013) led to the RPI Act. The Act claims to seek to strike a balance between protecting priority agricultural areas and strategic cropping areas and managing (and supporting coexistence with) mining and petroleum activities (Taylor & Hunter, 2019). Under the RPI Act, resource activities may require a Regional Interests Development Approval (RIDA). The government recently provided updated guidance for local governments by which the reference to coexistence merely states that "... gas resource development operations and other land uses are facilitated" (DSDILGP, 2021, p. 67). 'Balance' can only mean a compromise; and that can only mean that the pre-existing activity (farming) loses.

The RPI Act is not proving to be effective in moderating the industry, with public notification not always required for a RIDA application, and only to directly affected landholders holding appeal rights over decisions. At the time of writing, no application for a RIDA has ever been refused, and only minimal, if any, conditions are placed on the approvals.

Gas operators are able to self-assess whether or not an exemption applies to their activities without any notification process, and we are not aware of any regular procedure in place by the government to check the validity of the self-assessment. In the recent review of the RPI Act's operation by the GasFields Commission, discussed above, the recommendations laudably seek to improve transparency around the self-assessment, but there was no recommendation to remove this self-assessment process (GFCQ, 2021b).

The RPI Act application often comes after the awarding of the environmental authority (EA), by which time the momentum built up in the process makes any rational assessment of the implications virtually impossible. The assessments for the EA and the petroleum tenures do not specifically require assessment of the impact of the activity on agricultural land and its productivity, although arguably this could be assessed as part of the 'public interest' element of the standard criteria for site-specific EAs. The regional or cumulative

effects of the CSG mining activity on agricultural land are not clearly considered in the awarding of the project-by-project EAs.

There are various points in the environmental legislation and the petroleum/gas legislation at which ministerial or officer-level discretion could be exercised in favour of the ‘public interest’, such as the “any special criteria” for issuing an authority to prospect in s. 43(1)(a) of the P&G Act (p. 83). It is open to the Minister to promulgate policy guidelines that would give a mandate to assessing officers to apply special criteria, without any need for legislation, but none are known.

Precautionary Principle

The ‘precautionary principle’ was established as national policy when the state and Commonwealth governments signed the *National Strategy for Ecologically Sustainable Development* in 1992 (AGPS, 1992; Emmery, 1993). The precautionary principle reads: “Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation” (Emmery, 1993, p. 31). The principle is reflected in the EPBC Act, including the Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources; and state laws such as the EP Act.

Evidence from Australia and overseas has provided sufficient warning signals to justify invoking this principle and at least pausing the industry until the potential weaknesses in the regime are plugged. A ‘pause’ has been applied by other jurisdictions in Australia via moratoriums on the industry and reviews of some gas activities, which has led to considerable legislative reform in the Northern Territory, Western Australia, New South Wales and Victoria (IESC, 2014; Victorian Government, 2015; Luke et al., 2018; Labinsky, 2019).

Contrastingly, the Queensland legislation is predicated on encouraging exploration in order to realise the state’s natural assets, then on allowing companies who have invested in identifying a resource to proceed to a production lease, if they can demonstrate financial viability and their own financial capacity. The legislation places the onus on the environmental assessors to justify refusal and, where significant concerns are raised, operates

on the presumption that they can be addressed by conditioning and adaptive management rather than refusal. This reliance on adaptive management is often not based on sufficient upfront environmental assessment to properly understand the baseline environment and ensure that the management and monitoring techniques conditioned are appropriate to the site and environmental circumstances (Rose & Pointon, 2018).

Clearly, the best time to apply the precautionary principle and assess the possible risks of a project is when considering whether to issue an authority to prospect. Once a company has invested in exploring and proving up the viability of the field, the pressure to allow the extraction to proceed to maturity is considerable. Unfortunately, the EP Act allows environmental authorities for exploration activities to go through a ‘standard application’ process, with no reference to the precautionary principle in the criteria or conditions. This is particularly concerning given the emerging evidence on groundwater aquifer interactions and the significant hydrogeological impacts of the industry.

That saline effluent is still being stored in large dams some 25 years after this was deemed to be an unsatisfactory method of permanent disposal says much about the willingness of the Queensland Government to abrogate the precautionary principle. Although the dams are plastic-lined, there is no precedent for confidence that such material will not become brittle in sunlight and/or be able *in perpetuity* to prevent the escape of salt into the soil and run-off.

Carbon Dioxide and Methane Emissions

Atmospheric carbon is not regulated as a pollutant under the *Environmental Protection (Air) Policy 2019*, so the propensity of a coal seam gas operation to release methane or carbon dioxide need not be assessed under an environmental authority. There are no legislated limitations on these emissions, nor need emissions be monitored and reported as a standard condition. The carbon profile of the industry is left to a federal requirement that the industry reports their emissions (often modelled rather than monitored on site) to the Commonwealth’s Australian National Greenhouse Accounts, a demonstrably inadequate means of accounting for and mitigating emissions.

Fugitive emissions are produced at numerous points of the CSG production chain. While gas is touted as a ‘transition fuel’ between coal-fired electricity and renewables, its emissions profile is lower than coal only if counting is confined to the end-user activity (Lafleur et al., 2016; Swann, 2020). Significant volumes of methane gas are vented or flared (burnt) before a well is connected to the pipeline grid. Once a well is producing, it cannot easily be halted without flooding the seam (requiring the dewatering to be repeated), so considerable quantities of gas can be wasted.

Further, existing faults and fissures in the Condamine Alluvium may allow gas from the seam to escape through the earth surface. Depressurising the underlying coal seam during mining appears likely to have facilitated gas bubbling to the surface into the Condamine River through existing and newly created fissures and faults in the strata above the coal seam (Mudd, 2012; GISERA, 2017). The gas in the coal seams is held in place by the groundwater pressure, which is usually higher than for the Condamine Alluvium aquifer above the seams. Gas bubbling has been observed in the Condamine River and its tributaries for more than 100 years. But the difference now is that gas is anecdotally observed much more frequently and abundantly than historically, and the gas bubbles can even be easily ignited (Williams, 2016; Fritz, 2016).

Insurance

Australia’s largest insurance company, Insurance Australia Group (IAG), has said it no longer will cover farmers for any non-farming related public liability if they have CSG infrastructure on their property, including risks arising from groundwater contamination or loss, even if there is a CCA between the landholder and the gas company (Morris, 2021a). If this policy is confirmed and becomes a general practice of insurers, it signposts a transfer of risk from companies with extensive geological, hydrological and engineering expertise and large financial resources to landholders, the stakeholder entity least capable of managing the risk. Undertakings by the gas companies to promise coverage under a self-insurance scheme are valid only so long as the companies remain in existence, retain a legal connection to any properties affected and choose to honour the agreements.

The GasFields Commission working group has brokered a *Landholder Indemnity Clause* which does not address major concerns such as identifying the landholders’ land rights into the future from damage caused by the mining, especially with regard to underground water resources, subsidence or under-drilling without a CCA (GFCQ, 2022b).

Self-regulation Prior to Environmental Assessment

The integrity of the environmental assessment of gas activities in Queensland has many questionable aspects, which is especially concerning given that the footprint of CSG mining is the largest of any mining activity in Queensland. The extent of company self-assessment in the procedure for applying for an EA is particularly troubling (see Note 7 in Supplementary Material). The standard EA for an authority to prospect typically requires self-assessment against broad eligibility criteria and standard conditions. If it is considered that the company meets these criteria and conditions, DES cannot refuse the application, regardless of outside circumstances that may make the application inappropriate (EP Act s. 170). The progression from an EA for exploration to an EA for production is often approved by minor or major amendment of the exploration EA. Minor amendments are not publicly notified, and the Department has a discretion as to whether to publicly notify major amendments. Thus, major amendments to EAs may be approved without any public scrutiny.

An example is that the number of wells allowed to be drilled by the Santos Mahalo gas project in the Bowen Basin of the Surat Cumulative Management Area doubled to 383 and two new tenures hundreds of kilometres from the previously approved tenures were added, by amendments approved in 2017. This project has never been scrutinised through an environmental impact statement. These major amendments were not notified to the public. The project is located on strategic cropping land and priority agricultural areas and hence should seemingly be regulated under the RPI Act, but no application for assessment appears to have been lodged, and it is not obvious what exemption may apply, if any. The RPI Act relies heavily on self-assessment by proponents, even as to whether an exemption applies.

Self-regulation Substitutes for Compliance

Currently, regulators do little independent field monitoring, rely on gas companies to self-regulate and report, and act on complaints only if they choose to do so. The *Mineral and Energy Resources (Common Provisions) Act 2014* was enacted to streamline the various mining and resource laws and facilitate negotiation by resource companies and landowners around land access by the resource tenure-holder (see Note 8 in Supplementary Material).

There is scant information about compliance of companies with the conditions in the EAs, as DES does not publish details of “penalty infringement notices” (DES, 2021d), which are the most common compliance tools used. Companies in turn are not required to publish their response or their compliance with the EA conditions in their annual reports. In Queensland, compliance activities are not required to be reported in annual reports from resource operators, as is required in other states. Companies in the main self-report their compliance, and as Departmental on-site audits are infrequent compared to the number of projects operating, the likelihood of recording breaches is slight.

Reporting of fugitive methane and carbon dioxide emissions, let alone all Scope 1, 2 and 3 emissions, is a case in point. Current fragmentary evidence indicates they are grossly under-reported. For example, CSG companies have been shown by infrared optical gas photography to illegally vent rather than capture the gas that accumulates in the water-gathering lines (Dougall & Evans, 2020). In 2021 an aerial survey of the Surat Basin, Queensland’s main CSG region, discovered that methane emissions were two to three times higher than has been reported (Neininger et al., 2021). Transparency would help to ensure that compliance is taken seriously, improving community confidence in the government, industry’s social licence and respect for the law.

Conclusions

The life expectancy of the CSG industry in the Surat Basin is 30 or more years according to the production permits already issued for the Surat Cumulative Management Area (OGIA, 2019). The 2021 draft *OGIA Underground Water Impact Report* for the Surat Cumulative Management Area

acknowledges that there are likely to be impacts for landholdings used for dryland and irrigated cropping. Yet this is inconsistent with the stated Queensland Government strategy to double agricultural production by 2040.

Landholders have been farming on the Darling Downs for well over 150 years. Done sustainably, farming arguably could continue indefinitely, putting aside risks posed by climate change. Coal seam gas mining threatens the sustainability of production of food and fibre in the Surat Cumulative Management Area, especially on the Darling Downs and Condamine Alluvium. Through poor regulation of impacts to ground and surface water resources, risk of subsidence and inadequate management of CSG-produced water, these precious agricultural lands are being put at long-term risk, threatening the future of agriculture in the region as well as the natural environment.

The dispersed, unclear regulation across multiple agencies of the interaction between the gas industry and landholders has created significant confusion and led to a loss of social licence of the gas industry in the areas it operates. This is heightened by failures in the statutory regime to protect the environment and landholders’ interests by adequate assessment upfront of activities prior to approval. The focus on ‘coexistence’ has been undermined by this poor regulation and governance, which is disregarding the precautionary principle and the property rights of landholders. Where landholders are coerced into agreements under significant power imbalances, these agreements and the broader regulatory framework are not protecting the long-term viability of agriculture in one of Queensland’s prime agricultural regions and are eroding trust in governments.

Given the accelerating rate of decarbonisation of the national economy and the significant greenhouse emissions of the gas industry, attention must now be given to phasing down this industry and remediating its infrastructure, but no feasible path towards securely stabilising in perpetuity the thousands of wells being drilled is visible. Nor is it clear that the cost of remediation, even if that were practicable for bores hundreds of metres deep, will be charged to the activity causing the need.

The performance-based statutory regime (which does not envisage refusal of applications and does not

adequately monitor performance), the fragmentation of accountability across multiple authorities, the absence of any systematic resolution of landholders' concerns over many years and the statement in 2021 by the Acting Director-General of the Department that companies, not the regulator, are responsible

for gaining the community's trust, are all evidence that the Queensland Government conceives of its role simply as facilitating this problematic industry and that the 'public interest' which the electorate appoints it to protect has no dimensions other than the narrow one of gas production.

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